

Patent Claims

1. A power module having a first substrate (1) populated with power semiconductor chips (4), and
5 having a second substrate (2) populated with signal semiconductor chips (5), the substrates (1, 2) in the power module (3) being oriented parallel one above the other and their placement sides (7, 8) being arranged facing one another, and bonding wires (9) bent in a
10 hingelike manner electrically connecting the two placement sides (7, 8) to one another and defining the distance (d) between the first and second substrates (1, 2) and mechanically fixing them in a plastic housing (18).

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2. The power module as claimed in claim 1, characterized in that
the first substrate (1) populated with power semiconductor chips (4) comprises a ceramic board (10).

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3. The power module as claimed in claim 1 or claim 2, characterized in that
the first substrate (1) populated with power semiconductor chips (4) comprises a multilayer ceramic
25 board (10).

4. The power module as claimed in one of the preceding claims, characterized in that

30 the second substrate (2) populated with signal semiconductor chips (5) comprises a printed circuit board (11) made of glass-fiber-reinforced plastic.

5. The power module as claimed in one of the preceding claims,

35 characterized in that
the second substrate (2) populated with signal semiconductor chips (5) comprises a multilayer printed

circuit board (11) comprising glass-fiber-reinforced plastic.

6. The power module as claimed in one of the preceding claims, characterized in that the second substrate (2) populated with signal semiconductor chips (5) includes logic semiconductor components (12).

7. The power module as claimed in one of the preceding claims, characterized in that the second substrate (2) populated with signal semiconductor chips (5) includes semiconductor chips (5) with integrated control circuits.

8. The power module as claimed in one of the preceding claims, characterized in that the second substrate (2) populated with signal semiconductor chips (5) includes semiconductor chips (5) with integrated driver circuits.

9. The power module as claimed in one of the preceding claims, characterized in that the second substrate (2) populated with signal semiconductor chips (5) includes semiconductor chips (5) with temperature sensors.

10. The power module as claimed in one of the preceding claims, characterized in that the second substrate (2) populated with signal semiconductor chips (5) includes semiconductor chips (5) with passive components, such as resistors, capacitors or inductances.

11. The power module as claimed in one of the preceding claims, characterized in that

5 the first substrate (1) populated with power semiconductor chips (4) includes semiconductor chips (4) with insulated gate bipolar power transistors.

12. The power module as claimed in one of the preceding claims, characterized in that

10 the first substrate (1) populated with power semiconductor chips (4) includes semiconductor chips (4) with metal oxide power field effect transistors.

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13. The power module as claimed in one of the preceding claims, characterized in that

20 the power semiconductor chips (4) on the first substrate (1) are connected via bonding wires (13) and/or conductor tracks directly on the first substrate (1) among one another and to inner flat conductor ends (14) of external flat conductors (15).

25 14. The power module as claimed in one of the preceding claims, characterized in that

30 the signal semiconductor chips (5) are connected via conductor tracks on the second substrate (2) and the bonding wires (9) bent in hinge-type fashion to the power semiconductor chips (4) on the first substrate (1) electrically and/or to external flat conductors (15).

35 15. The power module as claimed in one of the preceding claims, characterized in that

the bonding wires (9) bent in hinge-type fashion

comprise aluminum and/or an aluminum alloy.

16. The power module as claimed in one of the preceding claims,

5 characterized in that

the bonding wires (9) bent in hinge-type fashion have a diameter of between 100 and 300 micrometers.

17. A method for producing a power module (3) having a
10 first substrate (1) populated with power semiconductor chips (4), and having a second substrate (2) populated with signal semiconductor chips (5), the substrates (1, 2) in the power module (3) being oriented parallel one above the other and their placement sides (7, 8) being
15 arranged facing one another, and bonding wires (9) bent in a hingelike manner electrically connecting the two placement sides (7, 8) to one another and defining the distance (d) between the first and second substrates (1, 2) and mechanically fixing them, the method having
20 the following method steps:

- provision of a first substrate (1) populated with power semiconductor chips (4), and of a second substrate (2) populated with signal semiconductor chips (5),
- 25 - orientation of the two substrates (1, 2) such that their placement sides (7, 8) are arranged next to one another and edge regions of the placement sides (7, 8) of the two substrates (1, 2) that have bonding areas (16) lie next to one another,
- 30 - connection of the substrates (1, 2) at the edge regions (17) that have bonding areas (16) to bonding wires (9) arranged next to one another in hinge-type fashion,
- folding over of the second substrate (2) through
35 180° with bending of the bonding wires (9) arranged in hinge-type fashion, so that the substrates (1, 2) are oriented parallel one above the other and their placement sides (7, 8) are

arranged facing one another,
- packaging of the power module (3) in a plastic housing (18).

5 18. The method as claimed in claim 17,
characterized in that
in order to provide a first substrate (1) with power
semiconductor chips (4), a ceramic board (10) is coated
with a conductor track structure having, in an edge
10 region (17), a row (19) of bonding areas (16) arranged
next to one another with a predetermined grid
dimension, the power semiconductor chips (4) being
arranged on the first substrate (1) and being connected
among one another and also to the conductor track
15 structure via bonding wires (13) with the bonding area
row (19) being left free, and in addition, on the
ceramic board (10), inner flat conductor ends (14) of
external flat conductors (15) being fixed with
connection to the conductor track structure.

20 19. The method as claimed in claim 17 or claim 18,
characterized in that
in order to provide a second substrate (2) with signal
semiconductor chips (5), a printed circuit board (11)
25 is provided with a conductor track structure having, in
an edge region, a row (20) of bonding areas (16)
arranged next to one another, the number and grid
dimension of which correspond to the bonding area row
(19) of the first substrate (1), the signal
30 semiconductor chips (5) being arranged on the second
substrate (2) and being connected among one another and
also to the conductor track structure via bonding wires
(13) with the bonding area row (20) being left free.

35 20. The method as claimed in one of claims 17 to 19,
characterized in that
in order to orient the two substrates (1, 2), the
bonding area rows (19, 20) of the substrates (1, 2) are

arranged next to one another, so that it is possible to produce bonding wires (9) on the oriented bonding areas (16) of the two substrates (1, 2) that are adapted to one another.

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21. The method as claimed in one of claims 17 to 20, characterized in that the substrates (1, 2) are connected by application of bonding wires (9) between the bonding areas (16) by means of thermocompression sonic bonding of aluminum and/or aluminum alloy bonding wires (9) with a diameter of between 100 and 300 micrometers.

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22. The method as claimed in one of claims 17 to 21, characterized in that the folding over of the second substrate (2) through 180° with bending of the bonding wires (9) arranged in hinge-type fashion, so that the substrates (1, 2) are oriented parallel one above the other and their placement sides (7, 8) are arranged facing one another, is effected by means of a vacuum tool.

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23. The method as claimed in one of claims 17 to 22, characterized in that the packaging of the power module (3) in a plastic housing (18) is effected by means of injection molding technology with the substrates (1, 2) arranged one above the other being embedded in a plastic housing composition (21).

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24. The method as claimed in one of claims 17 to 22, characterized in that the packaging of the power module (3) in a plastic housing (18) is effected by arranging the two substrates (1, 2) in a prefabricated plastic housing (22) and the cavities (23) between the substrates (1, 2) and the prefabricated plastic housing (22) are filled with silicone composition (24).

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25. The method as claimed in one of claims 17 to 22,
characterized in that

5 before the power module (3) is packaged in a plastic
housing (18), the first substrate (1) is mounted on a
metal board (25) preferably made of copper or a copper
alloy as heat sink, the metal board (25) forming an
outer wall of the plastic housing (18).

10 26. The method as claimed in one of claims 17 to 22,
characterized in that

after the power module (3) has been packaged in a
plastic housing (18), external flat conductors (15)
project from the plastic housing (18), which are
15 electrically connected on the one hand to the power
semiconductor chips (4) and on the other hand via the
bonding wires (9) bent in hinge-type fashion to the
signal semiconductor chips (5), external flat
conductors (15) having a larger cross section than
20 external flat conductors (15) for signal semiconductor
chips (5) being used as external flat conductors (15)
for the power semiconductor chips (4).